



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Hydrogen Safety Forum

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Representing

European Hydrogen Safety Panel
&
United States Hydrogen Safety Panel

22 June 2021

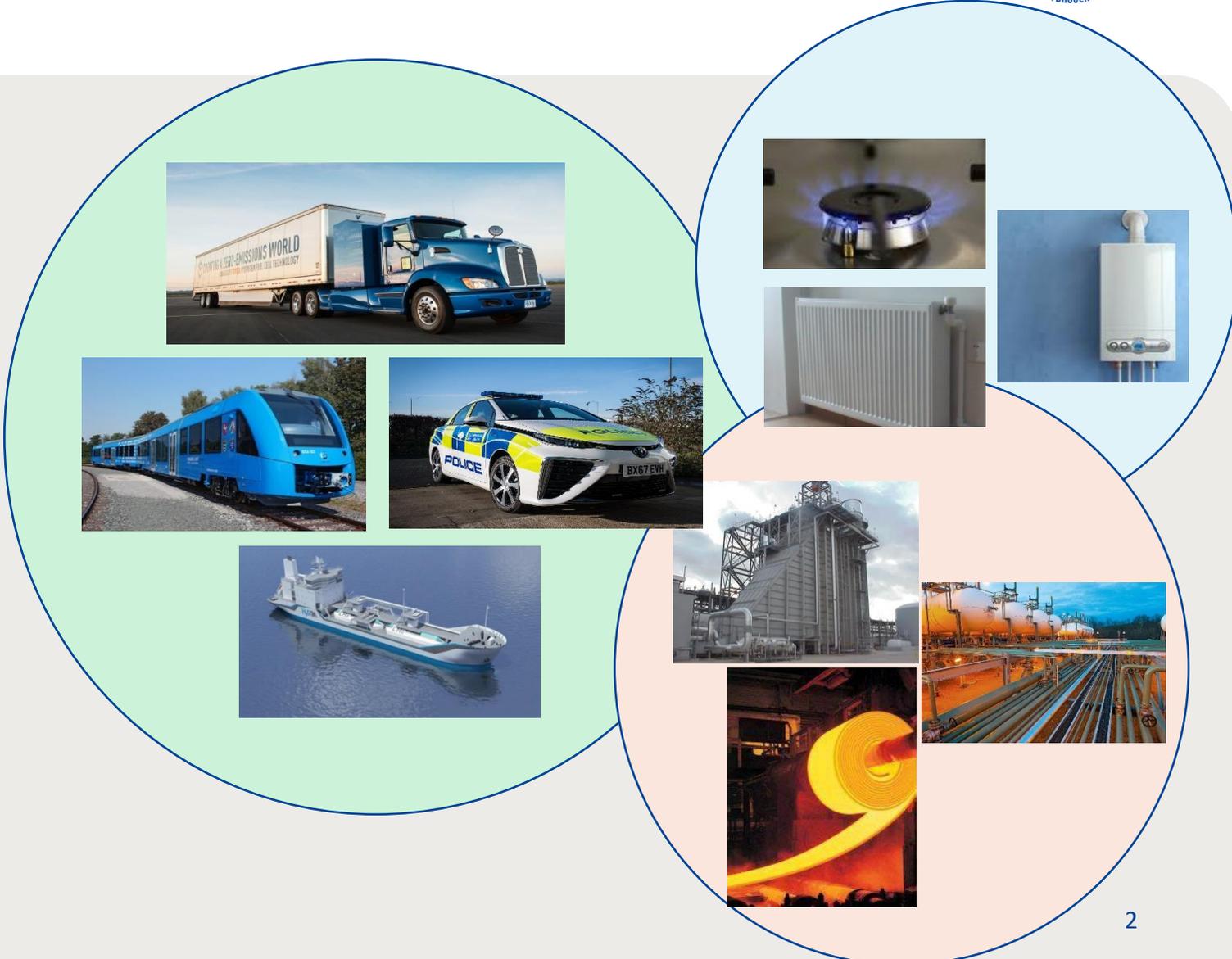


Presentation Aims

- What systems are in place to help ensure that industry and citizens can handle and use hydrogen in a safe manner? (Slides 3 to 7)

- How are the safety measures developed – what is the process? (Slides 7 to 11)

- Where can I find information on hydrogen safety from the basics through to what I should consider in putting hydrogen projects in place? (Slides 12 to 22)



Hydrogen – Safe Industrial Gas for 100+ Years



- Hydrogen has Been Used as a Safe Industrial Gas for Many Years (Refining Petroleum, Fertiliser & Food Manufacture, Metal Processing etc)
- Industrial Sites with High Levels of Control, Or Small Scale/ One-Off Applications.
- Looking Forward – H₂ Will Be A Widely Used Energy Vector Across Society.



The Evidence Cycle

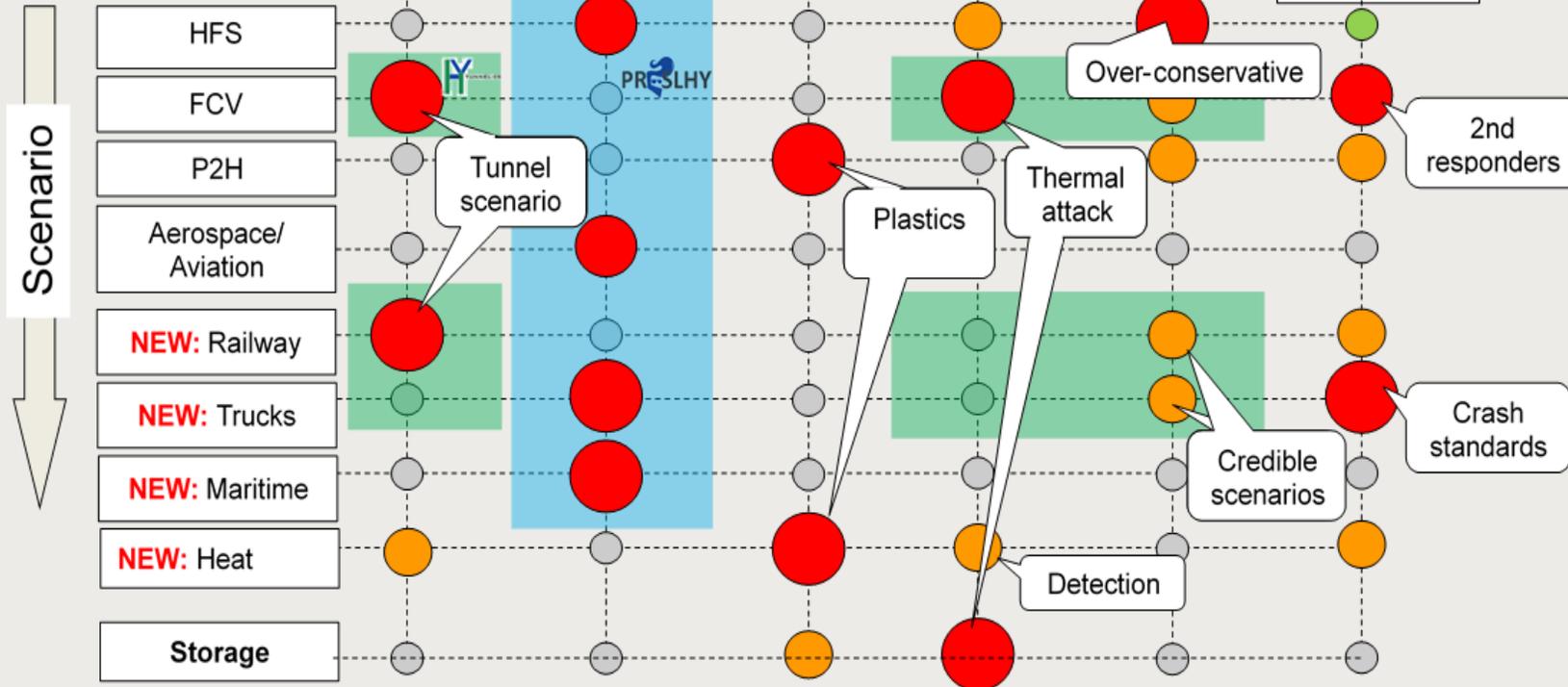
- Anticipating & Understanding Change
 - Future Looks Clear?
- Creating the Evidence Base
 - Science Based RCS
- Set Policy
 - Underpin Industrial Activities
- Protect
- Catalyse Engagement



Research Priorities



Risk Control →



Health and Safety Executive

International Association for Hydrogen Safety 'Research Priorities Workshop', September 2018, Buxton, UK

Prepared by the International Association for Hydrogen Safety and partners



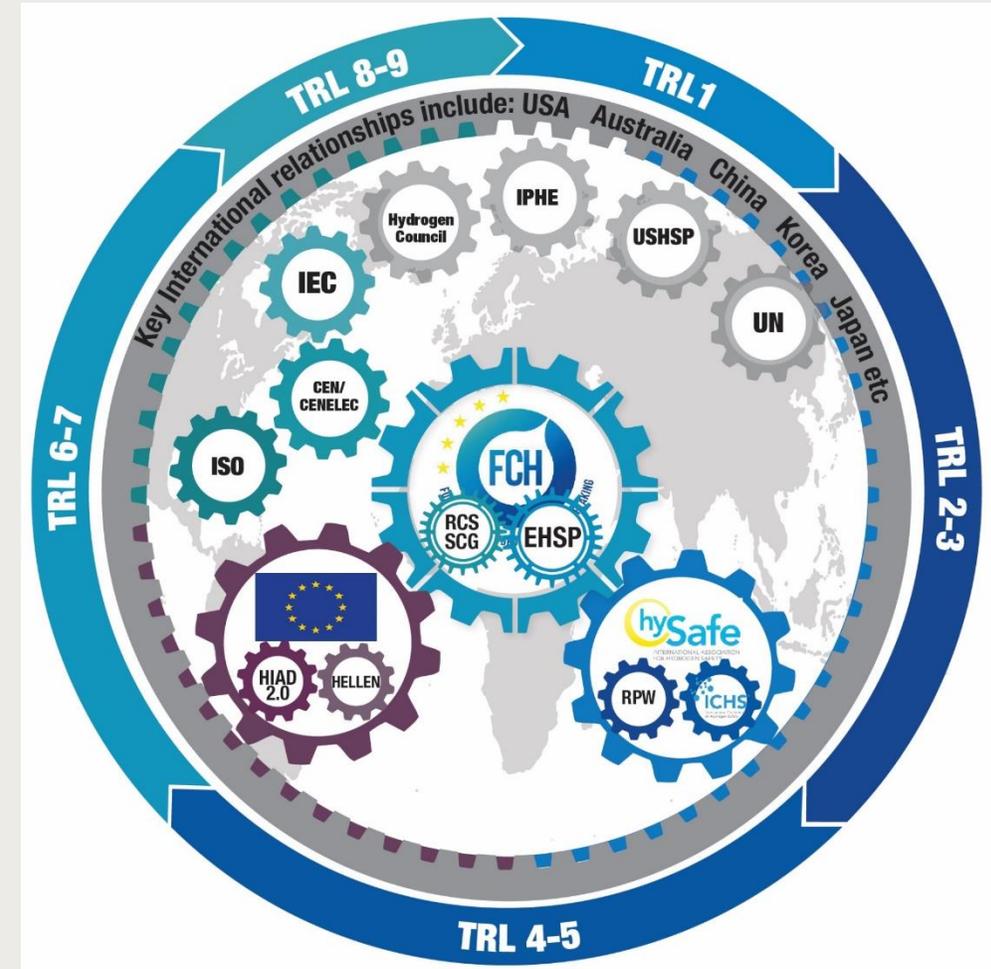
RR1159
Research Report



International Hydrogen Safety Community



- Close Coordination of Programmes and Activities
- Collaboration Between Programmes
- International & National Programmes including EU FCHJU, US DOE and others (China, Japan, UK etc)
- Key Stakeholder Bodies Involved In Coordination Activities.



Growing Applications



- Industrial Use of Hydrogen – Steel, Cement & Glass Manufacture, Power Generation etc
- Fuel Switching Programmes
- Extensive “Traditional” Industrial Use of Hydrogen to Build On.

- Aviation Initiatives to move to clean aviation fuels.
- Liquid Hydrogen Best Solution
- Significant Technological Change and Development aiming for operations in 2030s.



- Maritime Applications using Liquid Hydrogen (LH₂) and Hydrogen Carriers such as Ammonia.
- Maritime Fuel and Means of Moving Green Energy Around the World.
- EU funded projects HyShip, Ship FC & PRESLHY focused on LH₂.



Gas Grids – H2 Blending



Technology

Enable Blending 20% H₂ into Natural Gas System



<https://hydeploy.co.uk/>

Safety Measures

- Operated under an exemption from UK Gas Safety Management Regulations (GSMR 1996)
- GSMR Operates A Safety Case Regime.
- Exemption Issued by UK Statutory Authority, Health and Safety, on Acceptance of Safety Case.

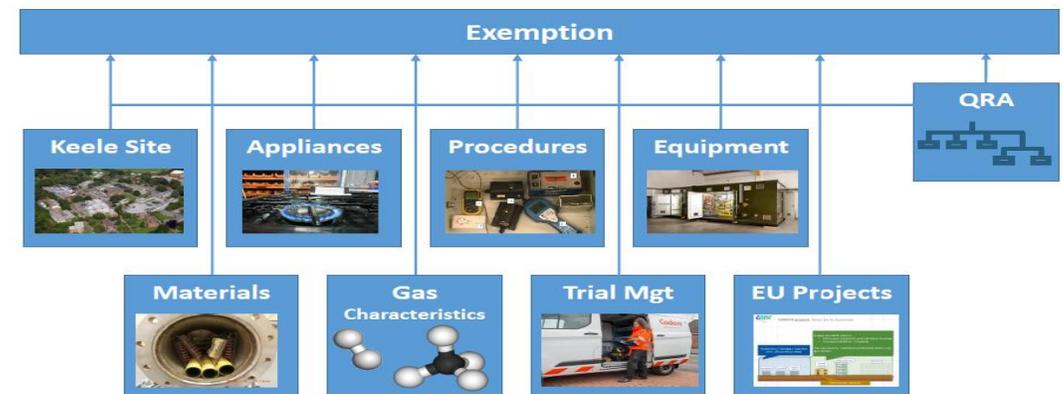


Implementation

- Other projects in France, Germany, Holland & USA (HyBlend Project)
- 12 Month Demonstration Successfully Completed on the University of Keele Site (approx. 100 buildings).
- Exemption Application Underway for 2nd Larger Phase (approx. 670 homes).
- Aim is to Enable Blending for 28 Million UK Customers.
- Ultimate Aim 100% H₂ Gas Grids - <https://h21.green>



Safety Process



42 documents with 1400 pages of documentation submitted

H2 Rail



Technology



Alstom I-Lint &
Alstom Breeze

Implementation

- Provides de-carbonised option to replace diesel trains without electrification infrastructure.
- Alstom I-Lint running in Germany and Netherlands (total order 40+ units)
- Projects in other countries including USA, UK have Alstom Breeze operational by 2023.

Safety Measures

- For Vehicle Design and Refuelling Infrastructure Drawing on Technology/ Experience from Passenger Vehicles and Buses.
- Operational safety in relation to built infrastructure being addressed as part of **FCHJU HyTunnel Project**.

Safety Process

- Established Risk Management Systems and Culture Already Established in Rail Industry.
- Approvals Against Design Standards Given by National Authorities



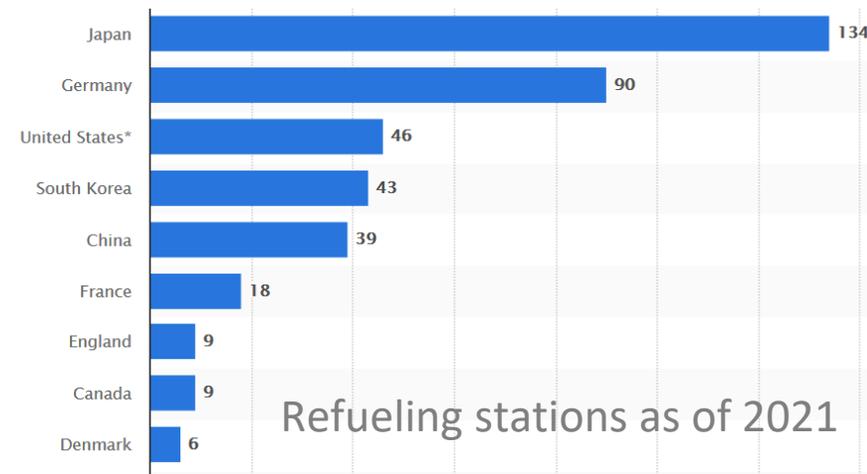
Passenger Vehicles



Technology



Implementation



Safety Measures

- Vehicle Safety - Global Technical Regulation for onboard tanks resiliency and reliability
- Infrastructure safety requirements – engineered safety to prevent leaks, risk assessment and mitigation (FCHJU MultHyFuel & HyTunnel Projects)



Safety Process

- Certification of vehicles by respective national transportation authority
- Refuelling protocol standardized
- Refuelling facilities permitted locally utilizing globally congruent regulations

Heavy Goods Vehicles



Technology



Nikola Tre



Howden.com

Implementation

- EU & several US states have mandated that from 2025, heavy-duty vehicles are getting strict limitations set on their CO2 emissions
- Infrastructure planned but not yet built for long haul transportation routes

Safety Measures

- Vehicle Safety – Hydrogen storage tanks meet same robust GTR requirements
- Infrastructure safety requirements – engineered safety to prevent leaks, risk assessment and mitigation



Safety Process

- Vehicles must meet the same standards as traditional fuels for crashworthiness
- Refuelling protocol in development via multinational project
- Refuelling facilities will be permitted locally utilizing globally congruent regulations

Hydrogen Safety Resources



- Centre for Hydrogen Safety / USHSP (www.H2Tools.org)
- European Hydrogen Safety Panel (www.fch.europa.eu/page/european-hydrogen-safety-panel)
- International Association for Hydrogen Safety (www.HySafe.info)
- International Standards ([ISO - ISO/TC 197 - Hydrogen technologies](#))
- National Bodies (NFPA, BSI, DIN HSE etc)



Safety Resources : Public Information

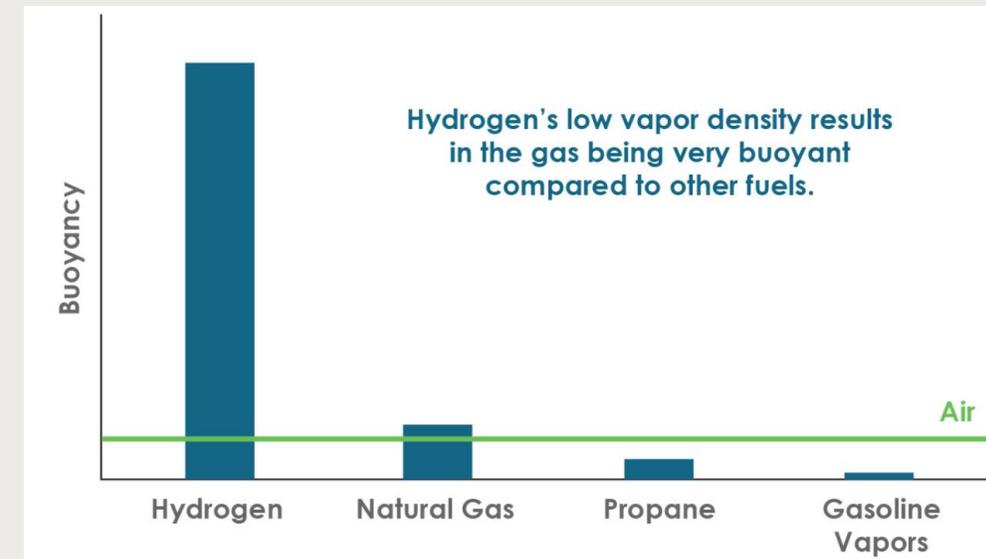


- General Hydrogen Information – Website with extensive resources including guidance documents, training materials, videos, incident database, and analysis center

<https://h2tools.org/>

- Worldwide Regulations - public website tracks the development of about 400 hydrogen and fuel cell standards

<http://www.fuelcellstandards.com/>



Safety Resources – Center for Hydrogen Safety



Vision

The Center for Hydrogen Safety (CHS) is a global non-profit dedicated to promoting hydrogen safety and best practices worldwide

Mission

Support and promote the safe handling and use of hydrogen across industrial/commercial uses and applications in the energy transition

Provide a common communication platform with a global scope to ensure safety information, guidance and expertise is available to all stakeholders

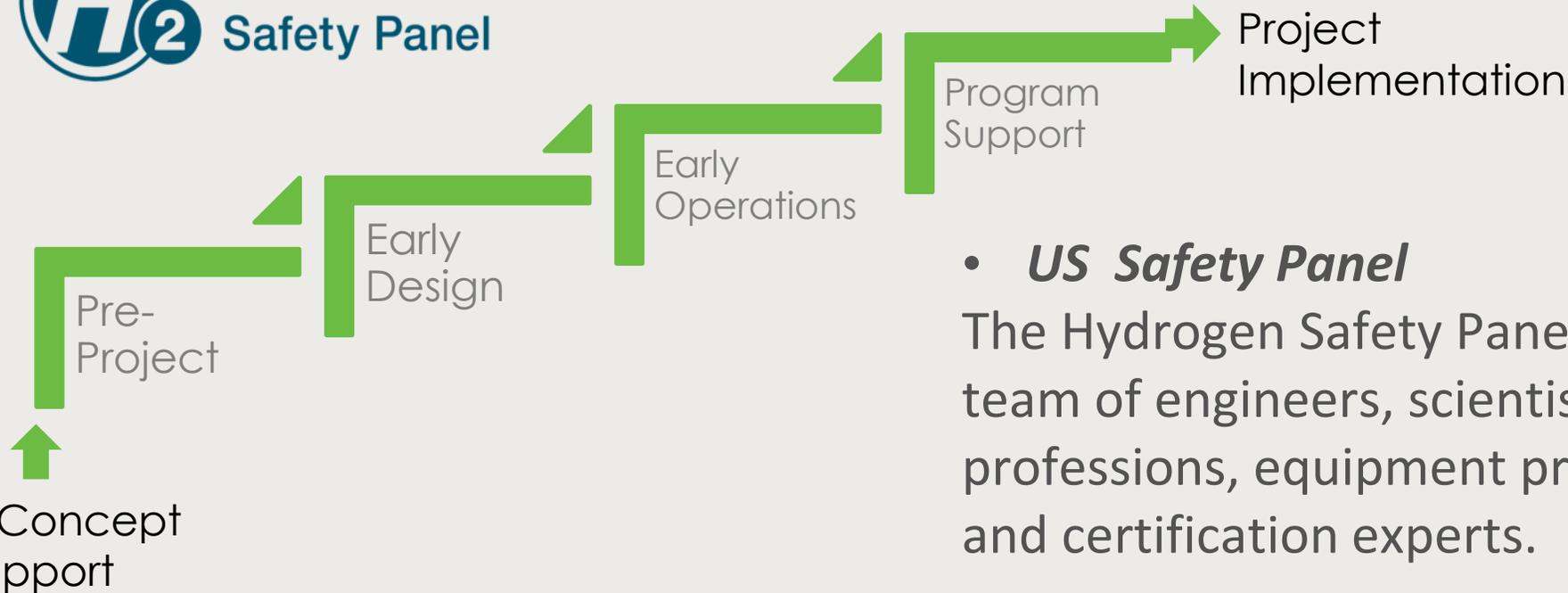


Bringing together a global membership to expand the body of safety knowledge

Safety Resources – Hydrogen Safety Panel



HYDROGEN
Safety Panel



- ***US Safety Panel***

The Hydrogen Safety Panel is multidisciplinary team of engineers, scientist, code officials, safety professions, equipment providers, and testing and certification experts.

- Established in 2003
- 16 Panel members on US Panel
- 500+ years of experience



EUROPEAN HYDROGEN SAFETY PANEL



The FCH 2 JU launched the European Hydrogen Safety Panel (EHSP) initiative in 2017. The mission of the EHSP is to assist both at programme and at project level to assure that hydrogen safety is adequately managed, and to promote and disseminate H2 safety culture within and outside of the FCH 2 JU programme.

The EHSP is composed of a multidisciplinary pool of 15 safety experts working in task forces. The scope and activities of the EHSP are structured around four main areas.



EHSP - Safety Planning For Hydrogen and Fuel Cell Projects



FUEL CELLS and HYDROGEN 2 JOINT UNDERTAKING
(FCH 2 JU)

SAFETY PLANNING FOR HYDROGEN AND FUEL CELL PROJECTS

05 July 2019

NOTICE

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EHSP: https://www.fch.europa.eu/sites/default/files/Safety_Planning_for_Hydrogen_and_Fuel_Cell_Projects_Release1p31_20190705.pdf

USHSP: https://h2tools.org/sites/default/files/Safety_Planning_for_Hydrogen_and_Fuel_Cell_Projects.pdf

Lessons Learnt from Incidents and Accidents - Enlargement and enhancement of HIAD 2.0



HIAD 2.0 front page

The number of validated incidents in HIAD 2.0 increased from 272 in 2018 to currently 577.

Sources of HIAD 2.0:

- Scientific literatures and news items.
- Other public not hydrogen-specific databases such as French ARIA, European (SEVESO) eMARS, US CSB, NTSB, OHS national nuclear authorities, etc.



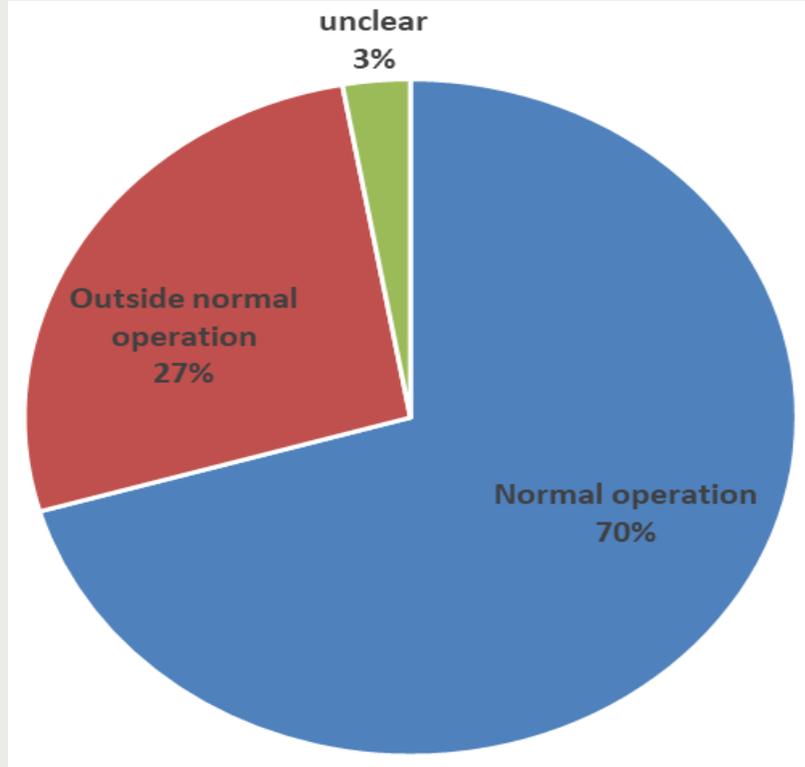
Temporarily Unavailable - request of assistance can be sent to pietro.moretto@ec.europa.eu

EHSP Lessons Learnt - Statistics analysis of the enlarged HIAD 2.0

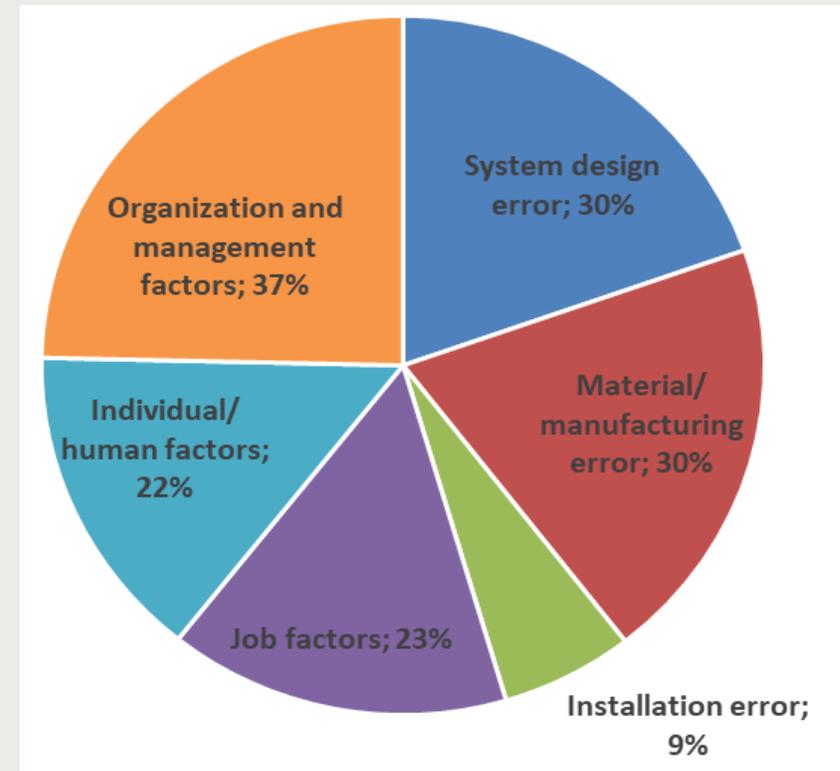


Normal operation

Outside normal operation: during maintenance or special services or immediately after returning to routine operation



Causes (multiple entries per incident possible)



9th INTERNATIONAL CONFERENCE ON HYDROGEN SAFETY 2021



Safe Hydrogen for Net Zero

Edinburgh, 21-24 September 2021



Scottish Government
Riaghaltas na h-Alba
gov.scot



Registration Open

<https://hysafe.info/ichs2021/>

SUMMARY



- **Significant Role for Hydrogen in Our Safe Net Zero Future**
- **Programme of International Activities - Extensive & Coordinated**
- **Applications – Established and Emerging**
- **The Approach:**
 - **Identifying Gaps**
 - **Building the Evidence Base**
 - **Incorporation in RCS**
 - **Engagement & Refining**



Thank You For Your Attention



- For Further Information/ Help Contact:

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Introductions



- **Chris LaFleur:** - Dr. Chris LaFleur is the program lead for Hydrogen Safety, Codes and Standards at Sandia National Laboratories in Albuquerque, NM. Chris is responsible for the fire risk program activities where her main research involves evaluating fire risks for emerging energy technologies. Chris is a licensed professional engineer and serves as the Chair of NFPA 2, Hydrogen Technologies Code and on the DOE Hydrogen Safety Panel.
- **Stuart Hawksworth:** Stuart has worked in the area of Industrial Safety for 28 years, leading a range of research projects and investigated major incidents including giving evidence at public enquiry. Current role is the Head of the Centre for Energy & Major Hazards at the Health and Safety Executive in the UK. He is also a Task Force leader in European Hydrogen Safety Panel (which is my role today), the President of the International Association for Hydrogen Safety and Visiting Professor at the Belfast School of Architecture & the Built Environment, University of Ulster.

